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Description

REMOTE DIAGNOSTICS DEVICE (RDU)

Cross Reference to Related Applications

[0001] This application claims the benefit of U.S. Provisional Application No. 60/412,595, filed September 20, 2002.

Background of Invention

[0002] The present invention relates to diagnostic units. It finds particular application in conjunction with diagnostic units used for vehicles and will be described with particular reference thereto. It will be appreciated, however, that the invention is also amenable to other applications.

[0003] Light emitting diodes (LEDs) on-board an electronic control unit (ECU) are used to indicate a finite number of faults on diagnostic units. Such diagnostic units are used for indicating faults in electronic systems (e.g., vehicle adaptive braking systems including an antilock braking system (ABS), transmission control systems, engine control systems, etc). An operator may reset and/or autoconfigure the ECU (e.g., via a switch). In this sense, the

LEDs are used as a first step in diagnosing a failure in an ABS. However, recent trends in locating ABS/automatic traction control (ATC) ECUs have tended to make on-board LEDs non-functional to the user in certain applications (e.g., where LEDs are hidden or difficult to see due to ECU location/orientation). In addition, although LEDs are not always used or desired by buyers, manufacturers tend to include on-board LEDs on all ECUs to accommodate the buyers that do utilize the LEDs. The cost of on-board LEDs introduces unnecessary burdens on ECU manufacturers and buyers in cases where LEDs are not used by the buyers.

[0004] For the reasons discussed above, ECUs that do not include diagnostic displays (e.g., on-board LEDs) are becoming more popular. Furthermore, for those customers who desire diagnostic information from the ECU, discrete diagnostic units have been developed to convey such information to a location remote from the ECU. For example, a diagnostic communication interface (DCI) unit has been disclosed in US Patent No. 6,114,952, ("the '952 patent") which is hereby incorporated by reference.

[0005] The DCI unit disclosed in the '952 patent communicates with a data bus (e.g., a serial data bus having a J1587 ve-

hicle diagnostic connector) via a cable. Furthermore, the DCI includes a plurality of LEDs for communicating diagnostic information from the ECU to an operator. However, when used by itself, the DCI of the '952 patent is only capable of interpreting proprietary messages received from the data bus. In order to interpret standard messages received from the ECU over the data bus, the DCI of the "952 patent must communicate with an external processor (e.g., a PC) via a port connector.

[0006] The present invention provides a new and improved apparatus and method which addresses the above-referenced problems.

Summary of Invention

[0007] In one embodiment, a remote diagnostic unit for use with a heavy vehicle includes a pin connector communicating with a data bus on the vehicle. The pin connector receives a signal from the data bus. A microcontroller receives and interprets a standard diagnostic message as a function of the signal received by the pin connector. A plurality of lights are controlled by the microcontroller as a function of the standard diagnostic message.

[0008] In one aspect, the microcontroller includes a UART.

[0009] In another aspect, a reset switch communicates with the microcontroller for at least one of clearing the diagnostic message from the microcontroller and resetting an ECU communicating with the data bus.

[0010] In another aspect, the diagnostic message indicates a status of an ABS ECU on the vehicle.

[0011] In another aspect, the data bus is a J1587 serial data bus. A plurality of the pin connectors communicate with the J1587 serial data bus.

[0012] In another aspect, a signal conditioner between the pin connector and the microcontroller conditions the signal received by the pin connector into the standard diagnostic message, which is interpreted by the microcontroller.

[0013] In another aspect, the signal conditioner is an RS485 device.

[0014] In another aspect, the microcontroller is a PIC16F870 device.

[0015] In another aspect, the lights include light emitting diodes.

[0016] In another embodiment, a remote diagnostic communication interface for use with a heavy vehicle includes a pin connector communicating with a data bus on the vehicle. The pin connector receives a signal from the data bus. The signal is conditioned for producing a standard diag-

nostic message as a function of the signal. The diagnostic message is interpreted. A plurality of lights are selectively illuminated as a function of the standard diagnostic message.

[0017] In another embodiment, a system for diagnosing an electrical system on a heavy vehicle includes an electronic control unit. A data bus communicates with the electronic control unit. A remote diagnostic unit includes a pin connector. A microcontroller receives and interprets a standard diagnostic message as a function of the signal received by the pin connector. A plurality of lights are controlled by the microcontroller as a function of the standard diagnostic message.

[0018] In another embodiment, a method for remotely displaying a fault status of an electronic control unit includes determining the fault status of the electronic control unit. A signal is transmitted from the electronic control unit to the data bus. The signal indicates a standard message for identifying a fault status of the electronic control unit. The signal is received into a remote diagnostic unit. The signal is interpreted as the standard message within the remote diagnostic unit. Selected lights are illuminated on the remote diagnostic unit as a function of the standard mes-

sage.

Brief Description of Drawings

[0019] In the accompanying drawings which are incorporated in and constitute a part of the specification, embodiments of the invention are illustrated, which, together with a general description of the invention given above, and the detailed description given below, serve to exemplify the embodiments of this invention.

[0020] *FIGURE 1* illustrates a diagrammatic illustration of a vehicle antilock diagnostic system using a remote diagnostic unit in accordance with one embodiment of the present invention;

[0021] *FIGURE 2* illustrates a perspective view of a front of the remote diagnostic unit in accordance with one embodiment of the present invention;

[0022] *FIGURE 3* illustrates a perspective view of a back of the remote diagnostic unit in accordance with one embodiment of the present invention;

[0023] *FIGURE 4* illustrates a perspective view of a vehicle connector in accordance with one embodiment of the present invention;

[0024] *FIGURE 5* illustrates a block diagram showing the functional relationship of the remote diagnostic components

in accordance with one embodiment of the present invention; and

[0025] *FIGURE 6* illustrates a detailed electrical schematic of the remote diagnostic unit in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION

[0026] With reference to *FIGURE 1*, a vehicle antilock diagnostic system *10* includes a remote diagnostic unit (RDU) *12*. An antilock electronic control unit (ECU) *14* is integrally mounted to a vehicle chassis including an associated antilock brake system (ABS)/automatic traction control (ATC) unit. In one embodiment, the vehicle is a heavy vehicle (e.g., a truck or bus); however, other types of vehicles are also contemplated. The ECU *14* communicates with the RDU *12* along a communication bus *16* (data bus) on the vehicle. In one embodiment, the communication bus *16* is a serial data bus having a J1587 vehicle diagnostic connector *20* to which the RDU *12* is connected.

[0027] The RDU *12* includes a plurality of lights *22a, 22b, 22c, 22d, 22e, 22f, 22g, 22h, 22i, 22j* (e.g., ten (10)) (see *FIGURE 2*), which provide a diagnostic check (e.g., a fault status) of the ABS/ATC and an indication that the RDU *12* has a power source and that a communications link is estab-

lished between the RDU *12* and the EDU *14* via the bus *16*. In one embodiment, the lights *22* are light emitting diodes (LEDs).

[0028] The ECU *14*, which comprises a part of the larger electronic diagnostic system *10* is housed within an enclosure which is mounted on the vehicle chassis. The ECU *14* further includes ports for connection to vehicle speed sensors and adaptive braking pressure modulators. The speed sensors are normally wheel speed sensors mounted at the vehicle wheels. Such sensors are conventional and provide a pulsed output which is transmitted to the ECU *14*, the frequency of the pulses being proportional to wheel velocity. The ECU *14* generates output signals which control one or more brake pressure modulators. The brake pressure modulators are known in the art and are also conventional. The brake pressure modulators are adapted to decrease and thereafter increase braking pressure in response to impending wheel lockup conditions detected by the ECU *14* as a function of the signals generated by the speed sensors.

[0029] The ECU *14* also includes diagnostics which check the ECU *14*, the modulators, wheel speed sensors, system voltage and for faults. The ECU *14* logs these faults and broad-

casts the fault status to the RDU *12* via the bus *16*. In response to such faults, a microcontroller *24* (see *FIGURE 5*) on the RDU *12* activates one or more of the LEDs, which are provided on the RDU *12* to indicate faults in the speed sensors, the modulators, or the ECU microprocessor *14*. Therefore, the lights are controlled as a function of the microcontroller and the standard message.

[0030] One or more discrete LEDs is provided for each of the possible faults detected, so that the mechanic servicing the vehicle can immediately tell, by examining the status of the LEDs on the RDU *12* which of the components of the system is malfunctioning. Since many of the malfunctions sensed by the aforementioned diagnostics are of a transient or temporary nature, and which are eliminated when the system powers down upon vehicle shutoff, a non-volatile random access memory in the ECU *12* is provided to store the faults detected by the aforementioned diagnostics. Therefore, upon powerup when the vehicle is started the same LEDs are again activated as were activated immediately before shutdown and are transmitted to the RDU *12*. A fault reset switch *26* (see *FIGURE 5*) on the RDU *12* is used for clearing (resetting) the ECU *14* (and the light emitting diodes) when the vehicle has been serviced

and the faults no longer exist. It is also contemplated that the fault reset switch *26* be used for causing the ECU *14* to cycle through a self-configuration mode.

[0031] With reference to *FIGURES 2 and 3*, the RDU *12* is an electronic, diagnostic tool for locating ABS/ATC faults. The RDU *12* includes the ten LEDs *22* and the fault reset switch *26* (see *FIGURE 5*). The LEDs *22* are used for indicating that the RDU *12* is receiving power, that a communication link is established between the RDU *12* and the ECU *14*, a position of a suspected issue in the ABS/ATC, and a suspected issue with a suspected component or its wiring. In one embodiment, the fault reset switch *26* is a magnetic reset switch that is responsive to a magnet being passed within a certain distance of the RDU *12*.

[0032] The RDU *12* is designed to be used as a stand-alone discrete unit for interpreting signals (messages) received from the bus *16*. In one embodiment, the signals transmitted from the ECU *14* are formatted according to a standard messaging protocol for the J1587 serial data bus ("standard messages"). The RDU *12* is capable of receiving and interpreting the standard messages. Because the RDU *12* is capable of interpreting messages formatted according to the standard messaging protocol, the RDU *12* is ca-

pable of receiving and interpreting messages from ABS/ATC ECUs manufactured by a variety of manufacturers as long as the ECU produces standard messages. Alternatively, it is contemplated in another embodiment that the RDU *12* is also capable of receiving and interpreting messages formatted according to a proprietary protocol.

[0033] With reference to *FIGURES 3 and 4*, the RDU *12* communicates with the bus *16* (see *FIGURE 1*) via an RDU connector *30* including nine (9) pin connectors *32a, 32b, 32c, 32d, 32e, 32f, 32g, 32h, 32i*. The vehicle connector *20* (e.g., a J1587 diagnostic link connector), which is typically located in the driver's compartment of the vehicle, includes nine (9) pin connectors *32a, 32b, 32c, 32d, 32e, 32f, 32g, 32h, 32i* that are designed to mate with the nine (9) pin connectors *32* of the RDU connector *30*. Although the illustrated embodiment includes nine (9) pins in the RDU connector *30* and the vehicle connector *20*, other embodiments including, for example, six (6) pin connectors are also contemplated.

[0034] With reference to *FIGURE 5*, power for the RDU *12* is supplied by a battery *36* (e.g., the vehicle battery), which supplies a +12 volt power including a ground to a +3.3 volt voltage regulator *38*. The voltage regulator *38* provides a constant, smooth +3.3 volt output for the various compo-

nents of the RDU *12*. The RDU connector *30* and the vehicle connector *20* connect the battery *36* to the voltage regulator *38* in the RDU *12*. Similarly, the RDU connector *30* and the vehicle connector *20* connect the RDU *12* to the ECU *14*.

[0035] Signals received in the RDU *12* from the ECU *14* are communicated to a driver/receiver *40* (conditioning means). The driver/receiver *40* receives the signals, which represent messages from the ECU *14*, and conditions the signals to be understood and processed by the microcontroller *24*. In other words, the driver/receiver *40* conditions the signals into signals (e.g., standard or proprietary messages) that can be understood and processed by the microcontroller *24*. Therefore, the signals (messages) received by the microcontroller *24* are generated by the driver/receiver *40* as a function of the signals transmitted from the ECU *14*.

[0036] The driver/receiver *40* also conditions information signals transmitted from the microcontroller *24*, which are transmitted as messages to the ECU *14* via the bus *16*. The driver/receiver *40* generates and sends an interrupt signal to the microcontroller *14* when the ECU attempts to send a message to the microcontroller *24*. The microcontroller *24*

reacts to the interrupt signal and reads the information from the driver/receiver *40*. As discussed above, the information is transmitted between the ECU *14* and the RDU *12* via the bus *16*, the RDU connector *30*, and the vehicle connector *20*. The signal header identifies the message to the microcontroller as an ABS diagnostic communication. If the message identifies an ABS fault, the microcontroller *24* activates various one(s) of the LEDs *22* through an LED driver circuit *42*.

[0037] The fault reset switch *26* is used to manually send a clear (reset) message to the ECU *14* when an ABS fault is corrected. Similarly, the fault reset switch *26* is used for sending a self-configuration command to the ECU *14* if, for example, the ECU *14* is configured incorrectly. In one embodiment, the reset switch *26* is sealed within the RDU *12* and is magnetically responsive. More specifically, the reset switch *26* is activated by placing a magnet within a range causing a magnetic response in the magnetic reset switch *26*. An activation of the magnetic response switch *26* for a first predetermined time, for example, greater than one (1) second but less than about twenty (20) seconds clears (resets) the current fault in the ECU *14* using a reset command. Therefore, all of the LEDs *22* turn-off. A

longer activation of the magnetic reset switch *26* (e.g., if the magnet is held within the range for activating the switch for a second predetermined time, for example, greater than about twenty (20) seconds but less than about sixty (60) seconds) causes the self-configuration command to be transmitted to the ECU *14*. The self-configuration command causes the ECU *14* to enter a re-configuration mode. In this embodiment, no action is performed if the magnetic reset switch *26* is activated for longer than about sixty (60) seconds. Furthermore, it is contemplated in this embodiment that the reset command is a standard command and the self-configuration command is a proprietary command; however, other embodiments, in which any command is either a standard command or proprietary command and is transmitted as a function of the fault reset switch *26*, are also contemplated.

[0038] With reference to *FIGURE 6*, a detailed electrical schematic including the microcontroller *24* and a conditioning circuit *44* in one embodiment of the present invention is illustrated. In this embodiment, the microcontroller *24* is a device including a universal asynchronous receiver/transmitter (UART) (e.g., a PIC16F870 device); also, the

conditioning circuit *44* includes the driver/receiver *40*, which is illustrated as an RS485 device. Although the microcontroller *24* is illustrated as a PIC16F870, it is to be understood that other embodiments, including other devices having a UART for transforming the signals transmitted from the ECU into the standard messages that can be interpreted by the microcontroller *24* are also contemplated. Similarly, it is to be understood that other embodiments, including other driver/receiver circuits having other devices, are also contemplated.

[0039] Although the present invention has been described with reference to an ABS ECU, it is to be understood that other embodiments in which the remote diagnostic unit indicates a fault status of other ECUs on the vehicle (e.g., a transmission ECU, an engine ECU, etc.) are also contemplated.

[0040] While the present invention has been illustrated by the description of embodiments thereof, and while the embodiments have been described in considerable detail, it is not the intention of the applicants to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. Therefore, the invention,

in its broader aspects, is not limited to the specific details, the representative apparatus, and illustrative examples shown and described. Accordingly, departures may be made from such details without departing from the spirit or scope of the applicant's general inventive concept.